<u>Urban Street Tree Priorities for Baltimore City's Watershed 263</u>

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Contributing Organizations

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Abstract

This study utilizes a software application developed by the US Forest Service to assess the structure and benefits of the street tree population within watershed 263, a 364 ha storm drain watershed located within the southwest section Baltimore city, Maryland. A sample inventory of city-owned street trees was taken from within the watershed and analyzed to compare that data to the city's overall urban tree canopy assessment and goals. The survey found that the urban tree canopy cover within watershed 263 was poorer that that of the city as a whole and that increasing the tree coverage within the watershed would allow both the watershed and Baltimore city meet goals of improving air and water quality.

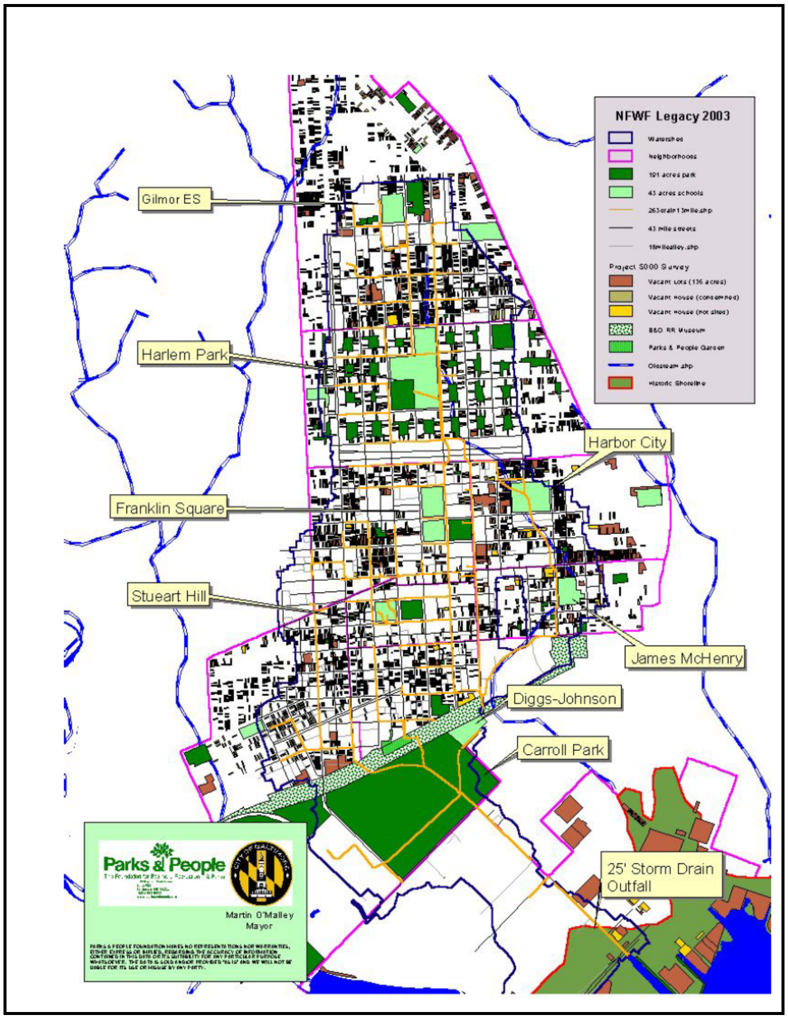
I. Introduction

Urbanization continues to be a major trend across the country (Pickett et al., 2007). Baltimore, Maryland is no exception to this trend; the region is following the same patterns seen within other major urban areas including "a thinning and reorganization of the urban core and a rapid suburban and exurban development (Pickett et al., 2007, 45.) Recently; however, the city has begun to experience a re-birth and population is estimated to grow within the next five years. More people are choosing to move back to Baltimore city taking advantage of lower housing costs and opportunities (Livebaltimore.com) and the city anticipates a large flux in population from the Defense Base Closure and Realignment (BRAC) implemented by the Federal Government.

Changes in the ecosystem occur as a result of urban growth and change, a number of researchers in the Baltimore area are studying how urban watersheds function as a result of these changes. One of the major concerns within Baltimore's watersheds is the relationship between the urban watershed's structure and function and the quality of water in the Chesapeake Bay (Pickett et al., 2007).

Increasing urban tree canopy (UTC) is one storm water management best practice that can improve the water in the Chesapeake Bay (Galvin et al., 2006). The Chesapeake Bay BMP Basics Handbook (available online at: http://www.chesapeakebay.net/pubs/waterqualitycriteria/BMPHandbook1-8f.pdf) discusses that maintaining current tree canopy levels and planting trees in urban and ultra urban areas can result in nutrient reductions. A study by Goetz et al. (2003) found that a UTC of 44.6% was associated with "good" ratings of stream health, lower UTCs were associated with lower rankings. Based on these finding Baltimore City adopted a goal to increase their overall UTC to 46.3%, slightly exceeding the targets set in the study (Galvin et al., 2006). Baltimore's administration has enacted a number of initiatives to "green" the city and increase UTC to this level, one of these strategies is Mayor's Greene's project called Tree Baltimore. Tree Baltimore's specific target is to double the city's tree canopy from 20% to 40% within 30 years in order to reap the many benefits that trees provide within the urban environment, as well as enhance the quality of the water in the Chesapeake (http://www.ci.baltimore.md.us/government/recnparks/ treeBaltimore.php).

Tree Baltimore's mission is aligned with one of the major goals of another city project, Baltimore's Watershed 263 project. Watershed 263 is one of Baltimore City's 355 storm sewer watersheds (sewersheds) and located within southwest Baltimore. The watershed drains into Baltimore Harbor's tidal estuary near the mouth of the Gywnns Falls, then leading to the Chesapeake Bay. The project is a collaborative effort between the city of Baltimore's Department of Public Works, Parks and People Foundation, and the communities within the watershed area (see map 1.0). The Department of Public Works Water Quality Management Division is in charge of Baltimore City's National Pollutant Discharge Elimination System (NPDES) permit, which requires watershed management plans to control non-point source pollution discharge in to rivers and streams. Due to increasing focus on storm sewersheds the project was conceived by Guy Hager of Parks and People and Bill stack of the Department of Parks and recreation as a "opportunit(y) for community residents and public and private sector experts in ecosystem research and restoration to work cooperatively on innovative approaches worthy of replication" (Parks and People, WS 263 Case Study). The watershed is urbanized, covered by approximately 75 percent impervious surface, 19 percent grass cover and approximately 5.9 percent UTC. Its UTC cover is lower on average than Baltimore's total average, which makes it a unique area to study the impact of UTC on stormwater quality.



Map 1.0 – Map of Watershed 263, Baltimore, MD (Credit: Parks & People)

Part of the watershed 263 project calls for assisting the communities within the watershed with tree planting, to increase tree canopy from its current 5.9 percent to an initial goal of 12 percent, eventually increasing the tree canopy to the current city average of 20 percent. To achieve this goal, at least 800 new trees would need to be planted, and the existing trees within the watershed will need to be maintained.

A second goal of the WS 263 project is to "quantify the effectiveness of best management practices to moderate storm flows and pollutant loads, and measure resulting environmental and quality of life outcomes" (http://www.homedepotfoundation.org/pdfs/ parks_people_3.pdf). Preliminary data collected within WS 263 shows very low water quality as compared to other watersheds in Baltimore City and County (Pickett et al., 2007). The water from this area goes directly into the Bay, untreated. The watershed exceeded EPA criteria up to 90 percent of the time for copper, up to 80 percent of the time for lead, and 25 percent of the time for zinc (based on measurements from 19 storm events). Nitrate concentrations were seen as high as 6 mg/L during low flow periods; this is equivalent to the concentrations found in agricultural watersheds of the Chesapeake Bay (Pickett et al., 2007).

This study will utilize the street tree analysis software to assess the current UTC within the watershed and compare that with Baltimore's most present UTC assessment (prepared for former Mayor Martin O'Malley, 2006). The study will also asses of impact urban street trees within Baltimore's watershed 263 as a best management practice for making improvements towards reaching the goals of the WS 263 project. A goal of this report is to provide information that may be used for making WS 263 a priority area in increasing UTC under the Tree Baltimore program in addition to the goals set forth in the WS 263 project plan because of the disparity of UTC between WS 263 and the rest of Baltimore.

II. Background

A. Benefits of increased tree canopy

Current literature suggests a number of benefits provided by urban street trees. The following is a brief discussion compiled from a review of the literature.

1. Economic Stability

According to the Maryland Department of Natural Resources, trees can have a positive impact on a community's economic stability in four ways:

- "by attracting businesses and tourists"
- "People linger and shop longer along tree-lined streets"
- "Apartments and offices in wooded areas rent more quickly, have higher occupancy rates, and tenants stay longer."
- Businesses leasing office space in wooded developments find their workers are more productive and absenteeism is reduced." (Maryland Department of Natural Resources Forestry Report, R8-FR 17/USDA Forest Service).

One estimate shows that businesses on "treescaped" streets can have a 12% higher income flow over non-treescaped business areas (Burden, 2006). In addition, homes and businesses in areas with street trees have an increased value of $15-25,000 compared to those in areas without street trees (Burden, 2006). A 7% increase has been observed for commercial office rental rates in areas "having quality landscaping" (Wolf, 2007). A 9-12% increase in consumer spending can occur in forested business districts (Wolf, 1995). These add up to more money coming into the community as a result of street trees and urban forests.

2. Energy Savings

Well landscaped properties are on average more valuable than non-landscaped ones. A survey of the sales of single family homes in Athens, Georgia (1978-80) showed that the homes landscaped with trees (5 or more in the front yard) had a 3.5-4.5% averaged increased sales price. The increased amount will vary state to state depending on a number of factors, including number of trees in the community overall (Anderson and Cordell, 1988).

Properly placed trees can reduce building energy use in the summer by shading the building and decreasing the temperature (Nowak, 1995). According to David Nowak of the USDA Forest Service, Syracuse, New York, the correct placement of the trees is extremely important because the benefits received in the summer time can be mitigated by trees blocking breezes in warmer weather and by increased usage of energy in the wintertime if trees shade the building too much. At the same time properly placed trees can also break cold wind in the wintertime (Maryland DNR Forestry Report, R8-FR 17).

Many of the examples of energy savings from urban trees are focused on more suburban areas; however, these benefits can also be applied to an inner-city environment. According to a report on urban forests in Chicago, "The potential for energy savings from new tree plantings is greatest in areas where tree cover is relatively low, such as public housing sites …Residents in public housing often spend a relatively large portion of their income for space conditioning, and these buildings seldom are energy efficient" (McPherson, et al., 1997).

3. Air Pollution

Baltimore's ozone (O_3) and particulate matter (PM_{10}) levels exceed federal air quality standards. Baltimore ranks as one the top counties in the United States with the most severe ozone concentrations. Air quality can severely impact the health of city residents, "causing asthma, coughing, headaches, repertory and heart disease, and cancer" (McPherson et. al, 2006, 19). The major source of the particulate matter is "coal-fired power plants, factories, and cars" (http://www.treescleanair.org/generalpublic/Articles /NAAQS_FineParticleFactSheet.pdf). Trees can help communities meet and sustain air quality standards for ozone and particulate matter as well as reduce carbon dioxide (CO_2). Trees sequester CO_2 in their stems and leaves as they grow (McPherson et. al, 2006). One tree can store up to 13 lbs of carbon annually (Coder, 1996). The removal of particulate matter is approximately 9% in deciduous trees and 13% in evergreens, this level increases to 60% for street level particulates (Coder, 1996). A 1994 study estimated that trees in New York City removed 1,821 metric tons of air pollution (an estimated $9.5 value to society). This amount was greater than Baltimore (499 metric tons), but the pollution removed per meter squared of canopy was similar (Nowak, 1995). The benefits to air quality from trees are localized. This can have a positive effect on the health of local populations. The American Lung Association estimates tens of thousands of premature deaths are attributed to fine particulate air pollution each year. Beyond this, trees can remove other pollutants from the atmosphere including nitrogen dioxide (NO_2) (Hewitt et al., undated, McPherson et. al, 2006) and sulfur dioxide (SO_2) (McPherson et. al, 2006).

4. Reduce stormwater runoff

Nonpoint source pollution is regulated by the EPA through the Clean Water Act (CWA), which provides grants to states to implement controls to reduce pollution. Street trees can be utilized as a best management practice in stormwater management by delaying stormwater entry into storm drains and reducing the peak rate of runoff. The surfaces of the leaves and branches of the tree both intercept and store water during rain reducing the volume of runoff and delaying the onset of peak flows (Nevada Division of Forestry, 2007, McPherson et. al, 2006). Roots decrease erosion, increase the rate that water is able to enter the soil, thereby reducing overland flow (Nevada Division of Forestry, 2007, McPherson et. al, 2006), and increases the soil's capacity to store rainwater. Transpiration through leaves also reduces the moisture of the soil which allows the soil to store more water during rainfall events (McPherson et. al, 2006).

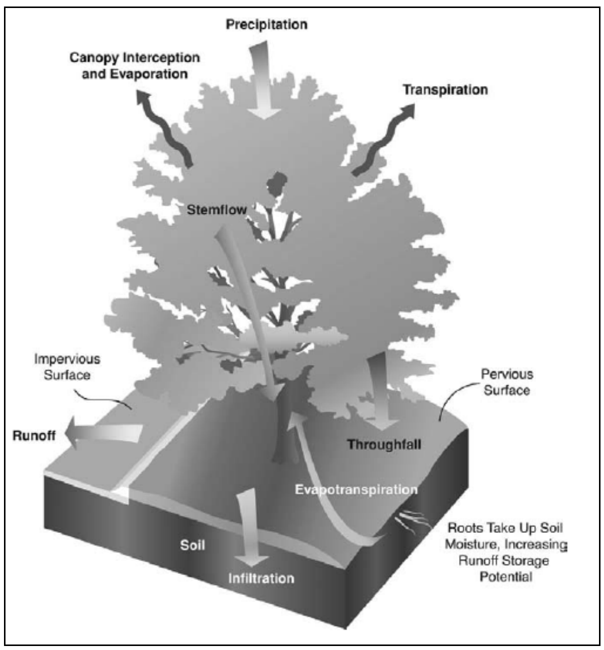


Figure 1 – illustration of the ways in which urban trees can reduce stormwater runoff (Credit: Mike Thomas, McPherson et. al, 2006)

B. Software

The USDA developed a software package entitled i-Tree, which allows communities to easily inventory, analyze, and forecast the ecosystem services provided by urban forests and city trees, and aid city managers and developers in their development management plans. STRATUM (Street Tree Resource Analysis Tools for Urban Forest Managers) is one application within the software package, which allows the user to specifically assess the city street tree populations.

The STRATUM software was utilized to calculate the following Benefit-Cost analyses:

1. Energy - the sum of energy savings due to reduced natural gas use in winter (measured in MBtu/tree/year) and reduced electricity use for air conditioning in summer (measured in kWh/tree/year).
2. Stormwater - a measure of reduced annual stormwater runoff due to trees (measured in hundred cubic feet [CCF]/tree/year).
3. Air quality - the sum of air pollutants (O3, NO2, SO2, PM10) deposited on tree surfaces and reduced emissions from power plants (NO2, PM10, VOCs, SO2) due to reduced electricity use (measured in pounds/tree/year). The model accounts for potential negative effects of trees on air quality due to BVOC emissions.
4. Carbon dioxide - the sum of decreased atmospheric CO2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use. The model accounts for CO2 released as trees die and decompose and CO2 released during the care and maintenance of trees.
5. Aesthetic/other - a measure of the tangible and intangible benefits of trees reflected in increases in property values due to trees.
6. Summary - the total of energy, stormwater, air quality, carbon dioxide, and aesthetic/other benefits. Reported as $ per tree or Total $. (http://www.itreetools.org/street_trees/introduction_step1.shtm).

These data provide a quantitative measurement based on the samples taking from the study site.

II. Methods

A. Study site

Watershed 263 is a 364 ha storm drain watershed located within the southwest section of the city of Baltimore. The annual average perception is 41.9 inches and average temperatures range from approximately 32° F in January- 77° F in July (city-data.com). The landuse is comprised of mixed industrial, institutional, and residential land uses. According to 2000 US Census data the population of Watershed 263 is 20,932 people. If the entirety of the 12 neighborhoods encompassed by WS 263 are included in this count the population rises to 41,588 (http://parksandpeople.org/publications/special_reports/Watershed%20263%20Case%20Study%20no%20maps.pdf).

B. Conducting the Sample Inventory

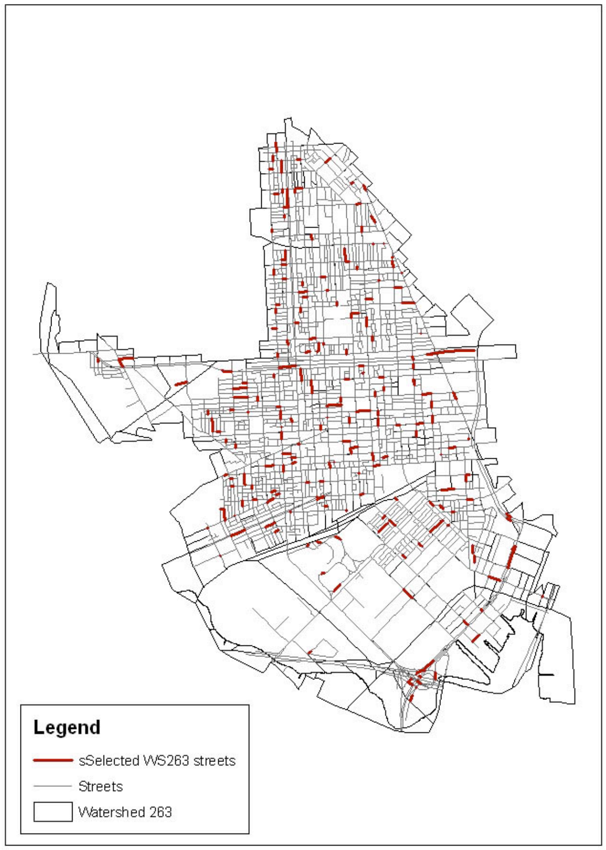
A STRATUM sample inventory project was chosen for data collection purposes. Streets for tree sampling were selected via a systematic sampling technique. Although the software comes equipped with *a Sample Street Segment Generator*, based on Census TIGER (street file) data, this program is incompatible with ArcGIS 9.2. Therefore, this alternate street selection method was chosen.

Streets were selected utilizing the attribute table from the WS 263 street shapefile provide by Parks & People Foundation, Baltimore. The attribute table indicated 4,053 street segments present within the watershed. Every 20th street from the attribute table was selected form the total population of street segments (see map 1) in order to achieve a sample of approximately 203 street segments. The equation to determine the number of street segments is as follows; based on the STRATUM software manuals recommendation that communities with less than 50,000 people utilize a sample size of approximately 6% of the communities' streets.

$$(\#\ Street\ segments)(\ .06) = \#\ street\ segments\ in\ sample$$

Those street segments that did not contain street addresses were removed from the sample population due to difficulty in locating exact sample plots. The total number of street segments remaining was 42. In total, 41 street segments were sampled. The 42nd street could not be located and therefore was not sampled.

WS263 - Study Area with Street Selections



Map 2 - Initial street segment selections in WS 263

After determining the street segments to sample all trees not fenced-in on private land were surveyed. The following data was collected from every tree on each of the selected street segments:

1. Tree species type
2. Diameter of trunk at breast height (4.5 ft from the ground)
3. Condition of the tree.
    - The Council of Tree and Landscape Appraisers (CLTA) have published a guide of standards to assess tree health (CTLA, 2000. Guide for Plant Appraisal, 9th Ed. Savoy, IL: ISA, 143 pp). These guidelines were implemented in determining the health of the tree species wood and leaves:
        - 1 = Dead or Dying - extreme problems
        - 2 = Poor - major problems
        - 3 = Fair - minor problems
        - 4 = Good - no apparent problems
4. Location of tree (planting strip, front or back yard, median, etc.)

5. Land use (residential, commercial, institutional, etc.) in the immediate area of the tree
6. The presence of any conflicts (sidewalk or utility wire)
    - Sidewalk damage, utilizing the following scale:
        - 1 = None – sidewalk heaved less than ¾ inch, requiring no remediation.
        - 2 = Low – sidewalk heaved ¾ to 1½ inches, requiring minor grinding or ramping.
        - 3 = Medium – sidewalk heaved 1½ to 3 inches, requiring grinding or ramping and/or replacement.
        - 4 = High – sidewalk heaved more than 3 inches, requiring complete removal and replacement.
    - Utility wire conflicts, utilizing the following scale:
        - 1 = No lines – no utility lines within vicinity of tree crown
        - 2 = Present and not conflicting – utility lines occur within vicinity of tree crown, but crown does not presently intersect wires.
        - 3 = Present and conflicting – utility lines occur and intersect with tree crown.

A three person team (a measurer, a recorder, and an assistant tree identification person) were used to record data onto a tally sheet, which was later entered into a computer Access file for analysis with the STRATUM software.

C. Assumptions, Scope and Limitations

This study assumes that the sample chosen represents the population of trees within the entire WS 263 area. In addition, it is assumed that the STRATUM software accurately measured the desired constructs of the study.

The scope of this study applies only to WS 263, other areas of Baltimore were not sampled. Information regarding Baltimore's overall UTC is pulled directly from published research. A major limitation in the study is the lack of information from city agencies. The STRATUM software requires inputs of financial data to run cost-benefit analysis pertaining to the management of street tree populations. The software allows the user to determine whether the cost of managing street trees outweighs the costs or visa versa. Financial data was requested from the city including;

1) Annual cost of tree planting in Baltimore
2) Annual cost of pruning
3) Annual cost of tree and stump removal and disposal
4) Annual cost of pest and disease control for trees

5) Annual cost to establish new trees (irrigation)
6) Annual price of repair/mitigation of infrastructure damage in relation to trees
7) Annual price of litter/storm clean-up
8) Average annual litigation and settlement due to tree-related claims
9) Annual expenditure for program administration
10) Annual expenditure for inspection/answer service requests
11) Other annual expenditure related to city trees

This request, as well as follow-ups, was not answered. The report therefore will not include any discussion regarding actual monetary cost-benefits of urban street trees in WS 263.

A second limitation pertains to tree identification. A STRATUM case study evaluation preformed in Minneapolis, Minnesota revealed that trained volunteers correctly identified tree species 80 percent of the time (Cozad et. al, 2005). This suggests that for the purposes of this study, the identification of tree species will not be 100 percent accurate. This study did not have experts to check the accuracy of identification. Tree surveying was conducted in the spring, before leaves had fully developed or opened on the majority of the trees, which may have resulted in an even lower level of identification accuracy than found in the Minneapolis case study.

A last limitation applies to the equations used by the software for energy analyses. As discussed in a similar study of street trees in Davis, California by Maco and McPherson (2003), the tree orientation and distance form buildings can affect the outcome on energy savings that trees provide. Adjusting the savings in heating and cooling is complex and has little overall effect on total savings.

III. Results

A. Resource Structure

Inventory data included 183 public trees sampled from 41 street segments within WS 263. Japanese zelkova represented the largest number of tree species in the watershed followed by Red maples (see figure 2). A previous inventory of species within WS 263 found that Tree of Heaven represented nearly 30% of the species population (data provided by Richard Pouyat and Ian Yesilonis, U.S. Forest Service).

The relative age of the species is important when determining the management needs of a tree population (Maco and McPherson, 2003). Relative age is determined by DBH. Table 1 shows the distribution of the DBH recorded within this sample of trees. As figure 3 represents, Japanese zelkova and Ginkgo are largely young tress, whereas the maple species represent some of the more established trees in the watershed. This suggests that the older species were abandoned in place of a number of new species planted heavily in the recent past. The does not appear to be an even distribution of ages. The graph appears to show higher numbers of species in the older and younger ranges with less in the middle ranges.

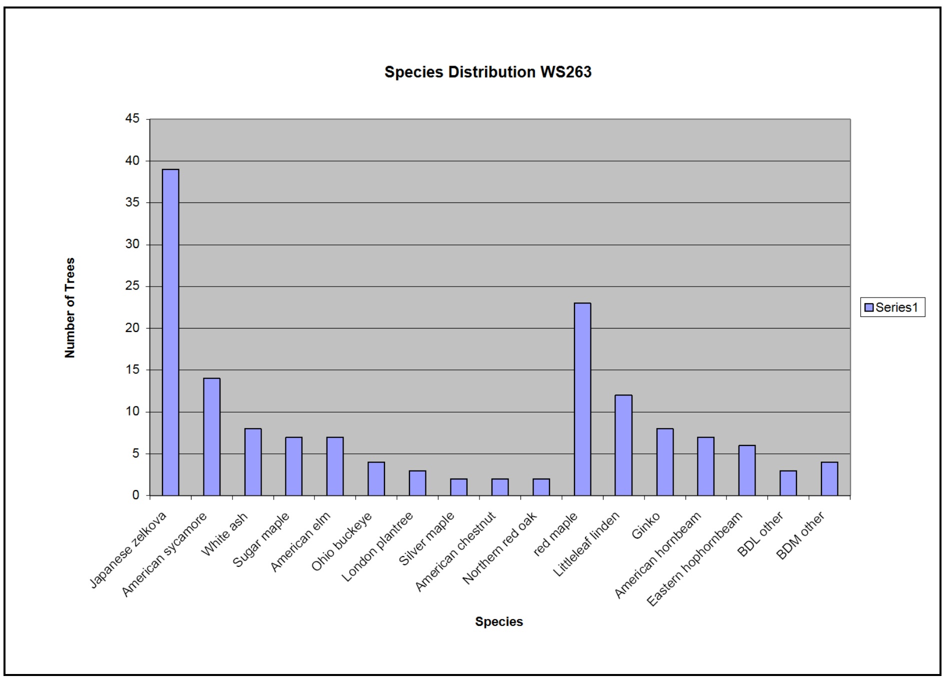


Figure 2- Species Distribution in WS 263

	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Japanese zelkova	0.0	0.0	41.0	12.8	7.7	10.3	5.1	5.1	17.9
Red maple	0.0	0.0	17.4	17.4	8.7	0.0	21.7	4.3	30.4
Yoshino flowering	0.0	0.0	18.8	25.0	12.5	0.0	18.8	12.5	12.5
American sycamore	0.0	0.0	0.0	0.0	7.1	0.0	0.0	35.7	57.1
Littleleaf linden	0.0	0.0	8.3	0.0	16.7	16.7	25.0	25.0	8.3
White ash	0.0	0.0	0.0	12.5	12.5	0.0	12.5	25.0	37.5
Ginkgo	0.0	0.0	50.0	12.5	0.0	0.0	0.0	12.5	25.0
American hornbeam	0.0	0.0	0.0	0.0	28.6	0.0	0.0	28.6	42.9
Sugar maple	0.0	0.0	14.3	14.3	57.1	0.0	0.0	14.3	0.0
American elm	0.0	0.0	14.3	28.6	14.3	0.0	28.6	14.3	0.0
Citywide total	0.0	0.0	18.6	13.1	15.3	6.0	10.4	14.8	21.9

Table 1 – DBH class for the top 10% of tree species within WS 263.

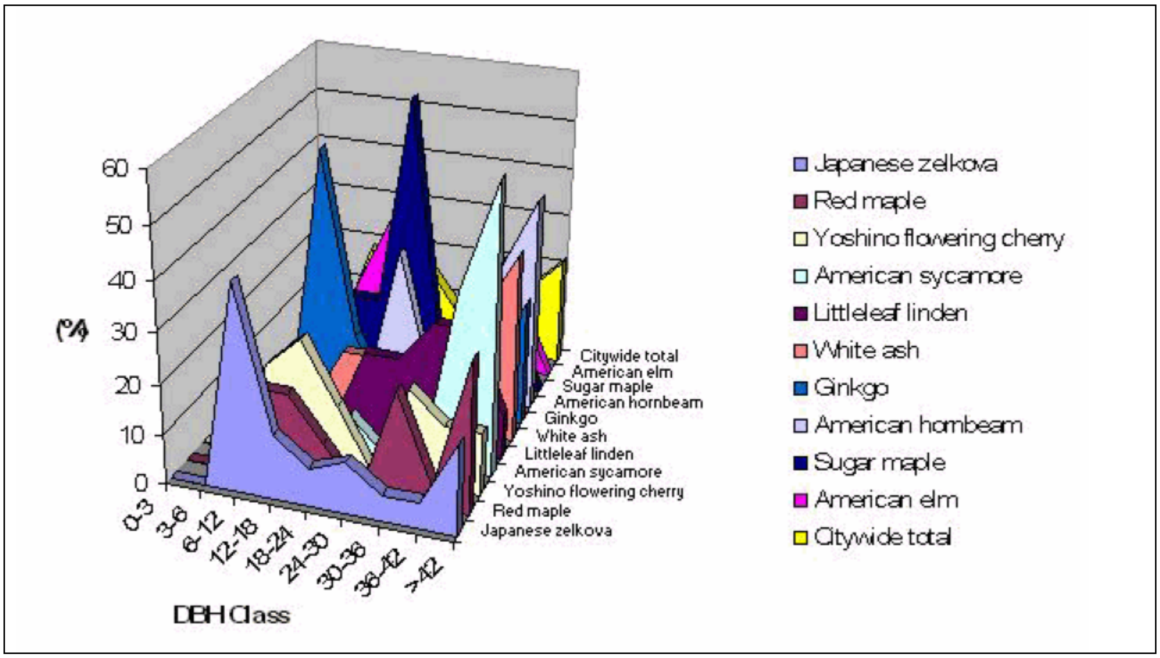


Figure 3 – Relative age distribution of trees within WS 263

The overall condition of trees within the watershed is good. Tree condition is an indicator of how well trees are managed as well as the relative performance in their location (Maco and McPherson, 2003). Trees in "good" condition accounted for 80 percent of the trees surveyed, while 20% ranged in condition from fair to dead or dying (see Figure 4).

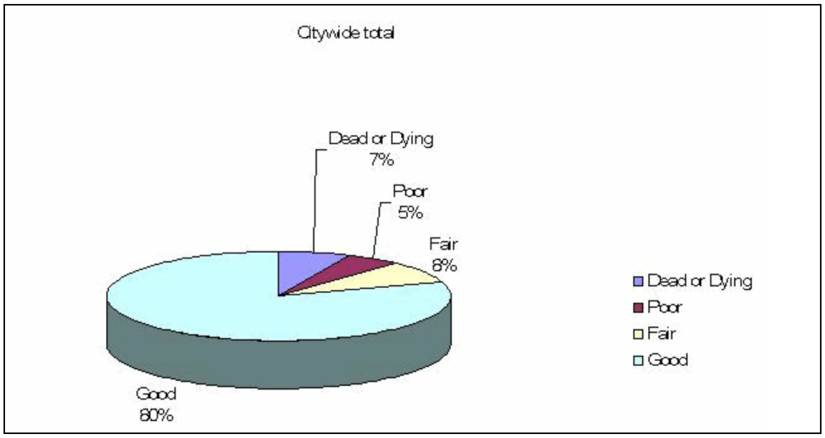


Figure 4 – Condition of trees within WS 263

B. Resource Function and Value

The tangible benefits of the trees within WS 263 are approximately $29,879. This total is derived from the total benefits in energy savings, reductions in CO_2, improvements in air quality, reduction in stormwater runoff, and aesthetic value. According to the data, the greatest value is attributed to stormwater runoff reductions, followed by aesthetic benefits (see table 2). Because no financial information was provided by the city, it is not possible to determine net benefits by subtracting expenditures. An analysis of expenditures may provide information that is very different than this analysis. For the purpose of this report, we will discuss only the raw data without associated costs.

Benefits	Total ($)	Standard Error	$/tree	Standard Error
Energy	3,907	(±)	21.35	(±)
CO2	772	(±)	4.22	(±)
Air Quality	1,072	(±)	5.86	(±)
Stormwater	13,151	(±)	71.86	(±)
Aesthetic/Other	10,977	(±)	59.98	(±)
Total Benefits	29,879	(±0)	163.27	(±0)

Table 2 – Total annual benefits produced by tress in WS 263

Different species vary in the benefits they produce. A closer look at the data reveals the lager tree species account for the higher amounts of benefits (see table 3), specifically red maple, American sycamore and red oak trees. A similar study in Davis, California showed that large- and medium-stature deciduous trees produced the most benefits (Maco and McPherson, 2003).

Baltimore

Annual Benefits of Public Trees by Species ($/tree)

5/3/2008

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
Japanese zelkova	20.63	3.31	4.88	67.38	56.59	152.79	(±)
Red maple	25.97	11.21	6.38	103.47	83.29	230.32	(±)
Yoshino flowering	11.89	1.24	4.69	20.71	17.54	56.08	(±)
American sycamore	37.88	3.84	7.67	155.07	62.87	267.33	(±)
Littleleaf linden	18.77	4.76	7.54	63.06	81.37	175.51	(±)
White ash	33.31	4.31	7.06	128.90	63.81	237.39	(±)
Ginkgo	13.15	2.23	5.19	37.09	55.13	112.79	(±)
American	19.44	3.42	7.83	65.14	84.06	179.89	(±)
Sugar maple	21.53	4.67	5.38	64.10	63.71	159.39	(±)
American elm	23.88	4.99	5.62	79.07	62.10	175.66	(±)
Eastern	20.52	0.83	8.29	71.89	89.44	190.96	(±)
Trident maple	12.85	1.02	5.53	22.75	17.08	59.23	(±)
Ohio buckeye	11.55	2.80	3.26	24.48	50.72	92.82	(±)
BDM OTHER	18.57	2.09	7.45	61.04	80.02	169.17	(±)
BDS OTHER	9.74	1.13	4.10	16.07	13.55	44.59	(±)
Pear	16.50	1.70	7.72	37.76	43.10	106.78	(±)
London planetree	25.59	3.39	6.00	85.23	64.43	184.64	(±)
Silver maple	19.20	6.04	5.98	50.17	70.67	152.05	(±)
American chestnut	21.95	4.92	5.74	60.14	69.38	162.14	(±)
Flowering dogwood	12.85	2.02	5.53	22.75	17.08	60.24	(±)
Northern red oak	28.12	8.20	-4.20	116.33	109.78	258.23	(±)
Other street trees	19.86	4.28	5.08	60.39	49.45	139.07	(±)

Table 3 – Annual Benefits of Public Trees by Species.

C. Comparison to Baltimore's UFORE Study

Baltimore recently conducted a city-wide analysis of its urban forest utilizing a second application within the i-Tree software package, UFORE (Urban Forest Effects), a computer model that calculates the structure, environmental effects and values of urban forests. UFORE is similar to STRATUM; its difference being that STRATUM analyzes only street tree populations. Much of the data collected for both the UFORE analysis and STRATUM analysis is similar and therefore lends itself to comparisons.

Baltimore's most recent UTC assessment shows that tree canopy covers approximately 20% of the land within the city (Tree Baltimore, Urban Forest Management Plan Draft, 2007). This report's findings found that within WS 263 canopy cover as percent of total land area is 0.01 percent (7 acres out of 932). Baltimore's total "tree cover varies by land use and is highest in "forests" (59.3 percent), followed by urban open (48.8 percent), medium/low density residential (32.4 percent), high-density residential (22.2 percent), institutional (12.4 percent), commercial/industrial (11.8 percent), transportation (10.0 percent), and barren land (0.8 percent) (Tree Baltimore, Urban Forest Management Plan Draft, 2007, 10). This report found a relatively similar distribution within WS 263 tree canopy cover, 0.05 percent for single family residential, 76 percent for multi-family residential, 4.9 percent for industrial/large commercial areas, 6.6 percent for small commercial areas, and 12 percent for parks/vacant/and other areas. The following figure illustrates the city's vegetative cover (figure 5) and lack of vegetation in the most heavily urbanized areas.

Figure 5 – Baltimore City Forest Cover and Vegetation (Credit: City of Baltimore, Parks and Recreation and U.S Forest Service)

Tree size throughout the entire city indicates that 66 percent are young trees with DBH less than 6 inches. These findings were somewhat different than those of WS 263, where the majority of trees had a DBH of either over 42 inches followed by those with a DBH of 6-12 inches (Tree Baltimore, Urban Forest Management Plan Draft, 2007).

Baltimore's assessment of tree conditions showed that the average life-span of all trees in Baltimore is only 15 years. Over half of the trees surveyed were in good or excellent condition, one quarter were in fair condition, and the last quarter in poor, dead or dying condition. 80 percent of the trees surveyed within WS 263 were in good condition. This difference may be attributed to the surveyors, as non-tree experts may not be able to accurately assess the condition of trees.

The environmental benefits of the UTC in Baltimore as a whole were $3.3 million per year in energy savings, $10.7 million for carbon storage, $219,000 per year in net carbon sequestration, and $3,757,000 per year for air pollution removal (Tree Baltimore, Urban Forest Management Plan Draft, 2007). The total benefits for WS 263 were $3,907 in energy savings, $772 in carbon storage, and $1,072 in air quality improvements.

IV. Conclusion and Recommendations

The sample inventory from WS 263 provided enough data to provide an approximate estimation of the environmental benefits from the street tree population within WS 263. The findings indicate that WS 263 lacks the benefits from UTC as compared to the entire city of Baltimore. Baltimore has only 20% UTC, lower than many other urban centers. Increasing UTC can not occur over the entire city concurrently, therefore based on the findings in this report it is recommended that the City set certain areas as priority tree planting areas where the UTC is most deficient, such as WS 263. The benefits of doing this will be seen as both an increase in overall UTC for the entire city, as well as meeting goals of the WS 263 project in increasing UTC and improving storm water runoff, in addition to improving the quality of water in the Chesapeake Bay. This would provide a win-win-win solution for the city of Baltimore and may set the standards for the rest of the city, using the WS 263 area as an example of best management practices.

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